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RESEARCH AND THE AMERICAN COLLEGE[1]

THERE are two zoological themes either of which I would like to discuss with you this evening, but instead of this I've decided to tell you something of a college which has recently been founded and of its ideal to promote research by leading a large proportion of its ablest pupils to adopt research as their life work.

This institution has fallen heir to 139 acres of land upon which are 17 buildings reasonably well adapted for continued use as laboratories, lecture halls, library, assembly halls and dormitories. It has $13,000,000 of productive endowment paying, as at present invested, 4.8 per cent. above the expenses of the care of the funds, that is $624,000 besides tuition fees, which amount to 500 times $200 or $100,000, making a total income of $724,000.

By provision of the charter the institution has no president, but in his stead is a chairman of the faculty who is also *ex-officio* chairman of the trustees. His successors are to be elected by vote of both faculty and trustees, agreement by each body being necessary. He is *ex-officio* a member of any committee of faculty or of trustees upon which he may desire to serve. This is in reality, though not in name, a return to the former condition of the New England college, a condition now abandoned in American colleges and universities with a few exceptions, notable among them Oberlin, in which the old tradition as to the presidency remains in force.

To the trustees is committed the investment and care of the funds of the college and the securing of additional funds. To the faculty is committed the determination of educational policies and all the educational administration of the institution, including the selection of members of the teaching staff, the library force and the secretarial and other assistants, except in the treasurer's office. The trustees estimate each year in advance the amount of funds to be available from all sources for the educational work of the institution and with this fundamental figure known the faculty plan the budget in detail, subject, however, to the approval of an executive committee upon which are an equal number of representatives elected by the

[1] Address of the chairman and president of Section F—Zoological Sciences—American Association for the Advancement of Science, Cincinnati, December 28, 1923.

faculty and by the trustees presided over by the joint chairman of faculty and trustees. This executive committee has authority to act for the trustees when they are not in session and for the faculty in emergency decisions that may need to be made during vacation periods when the faculty can not be convened.

But the matter of chief interest to us is the educational policy adopted by the faculty: (1) The number of students is limited to 500, the ideal of the college being quality not quantity of output; (2) the college has no teachers of less than professorial rank, except two classes: first, a very few are appointed to instructorships with the intention of advancing them to professorships within two years if they demonstrate ability as teachers and productive students in their field. They are all thoroughly trained and worthy of professorial rank except for experience. Second, there are laboratory and other assistants, but these do no teaching of any sort except jointly with and under the close supervision of professors. For example, in all laboratory work the pupils have constant association with the professors and are never under the guidance of assistants alone.

No teacher carries more than three full half-year courses, or their equivalent, during the year, that is, two full courses one semester and one course the next semester, and it is regarded as far preferable that not more than one full course or its equivalent should be carried at a time, except that seminar work or informal club direction, either field club or informal discussion club, may be undertaken. The institution is so jealous for the quality of its teaching that it demands that no member of its faculty shall undertake to do more than he can do as well as it is in him to do it. No quiz masters or readers of themes, laboratory notes or examination papers other than the professors in charge of the course or section are allowed, and all courses are so subdivided that not more than 25 or preferably 20 students are in any course or section. It is regarded as essential that the professor directing the course or section shall himself get the reaction of the student in all his written and other work so that he may know when and where and how the student is getting hold and how best he may be guided.

There is in the institution very little cut-and-dried work of the prevalent college sort. Personal consultation between teacher and pupil takes the place in large measure of the lecture or recitation method. There are almost no courses which require a specified amount of ground to be covered in a specified number of weeks. In many courses there are not daily class meetings, but the pupil does much of his work more or less by himself, but guided by means of very frequent personal interviews with his teacher. There is not in the whole institution a laboratory course in which there are supplied laboratory directions guiding the student's every motion. Student initiative and independence are highly prized and everything possible is done to conserve and promote them. This is clearly seen to be incompatible with teaching *en masse*, and in consequence the individual method is chosen whenever possible, and it is surprising to see to what extent it is possible to carry out this ideal. With a faculty more than twice as large as in any other college in the country with the same number of students, and with no professor carrying more than two courses at once and usually but one course at a time, such individual work becomes possible.

In the subject receiving major emphasis a bit of what might fairly be called research is done and there are several departments in which the professors have the students use research methods in part of their work almost from the beginning. This has proven so successful in toning up the whole quality of the students' work that the endeavor is now made to have nearly all sophomores and in especially promising cases to have freshmen get a taste of this type of work. In this way students who early in their course give evidence of special ability may do all their college work with that fine attitude which can come only to one who has once caught the spirit of productive scholarship, the spirit of research. A mere taste of this sort of work in a single department is enough to whet the appetite of the student in all his work.

Personal consultations between teacher and pupil are necessitated by another provision. The institution has absolutely abolished the whole system of grades. No grades are ever given the student for any examinations or for any work of any sort. No record of grades is kept by the college. A professor can not by merely giving a grade shirk a personal interview with a pupil deserving commendation and encouragement because of the excellence of his work, and there is no available method except personal conference for halting and redirecting the pupil who is going wrong. The teaching in this institution is genuine and real, and the professor who shirks this part of his job is likely to be asked by a committee of his colleagues to change his ways or withdraw.

I have said that no record of grades is kept by the college. This is true, but very full records of a much more valuable character are kept. Each teacher in every course fills out for each pupil a card which is filed in the college registrar's office. This card carries the instructor's annotation as to the work accomplished by the pupil, stated in three ways: First, telling the nature of the work done and the ground covered; second, telling of the degree of success in the work, its quality; third, estimating its equivalence in units of college work, one unit being 1–120 of a

normal full college course; and in addition there are annotations under such captions as industry, keenness, initiative, independence, inventiveness, judgment, versatility, breadth of vision, logical power, persistence, etc., and there are other remarks as to the student's relation to the work of the course and his revelation of his own qualities.

Throughout all the college work every effort is made to avoid the deadening effect upon both pupil and teacher of too much system and too stereotyped courses. The individual and individual relations are emphasized to the highest possible degree.

But the chief feature in the institution we haven't yet mentioned. It is the fact that every professor and each of the few instructors is expected to be productively active as a student in his chosen field. Not only is faithful and enthusiastic teaching demanded; equal stress is laid upon research, upon productive scholarship and growth. The teachers must be men of real devotion to their chosen fields, and this is emphasized as essential to successful teaching and to the creation of the most stimulating college atmosphere. The research is regarded as an essential part of the service of the college, as a vital part of the service for which salaries are paid. All realize that nothing else is so effective in inspiring college students to choose research for their life work as is contact with a teacher genuinely devoted to research, to creative scholarship. It is not the magnitude of the teacher's research or its far-reaching technical importance that counts most here. It is the spirit of genuine devotion to a field of study that gives the contagion, and this spirit somehow gets across to the pupil in many cases from teachers whose personality may seem to be very lacking in inspirational power.

This college gives each of its teachers half or more of his time and energy free from teaching and for use in research. It frowns upon the use of this free time for anything but productive scholarship, even the long vacations must not be used for teaching in other institutions rather than for research or for recuperative preparation for research. The whole atmosphere of the college is such that free time means to the members of its faculty freedom for research.

Though the college pays professorial salaries running according to grade only from $3,000 to $5,000 a year, the freedom from the swamping effect of too much teaching and the opportunity given for productive study and growth have been a great inducement and have enabled it to secure excellent men for its faculty. It is a college with a faculty of university grade in research and much better than university quality in teaching.

The effect upon the student body has already in these few years been noteworthy and there is indication of an increasing effect. The students have been carefuly selected for admission, only those being taken who seem, on the recommendation of their preparatory course instructors, to be likely to respond worthily to the special opportunities the college offers. The institution, through its salaried group of athletic leaders, has succeeded beyond its expectation in promoting gentleman's sport for sport's sake and has largely avoided the highly professional type of intercollegiate team contests for the glory of the school. Practically every student follows one or several athletic sports, but it is found that many of the ablest men refuse to give the time required for training for college teams. When the college was organized the policy of no intercollegiate team athletics was considered but was not adopted because of its being such a departure from American precedent. Intercollegiate athletics as it exists was recognized as about the most highly professionalized athletics in the country and of a sort to give much less of value for the college life and the after-life of the student than does gentleman's sport for sport's sake. Within the last year there has come up again the proposal to abandon intercollegiate team contests and the sentiment of both students and faculty seems to be swinging in that direction.

Intellectual interests are well to the fore in the student life and in a thoroughly wholesome way. There are no so-called grades in the college life, and the students in their studies work for interest in the subjects themselves to a far greater degree than in other colleges. Phi Beta Kappa has not been admitted because of the fear that it may help emphasize false standards of honors in place of work for the interest of the work itself. Sigma Xi, on the other hand, being devoted to the active promotion of research, has a very strong chapter with divisional meetings for the several sciences as well as general meetings.

But perhaps the best indication of the grip the real work of the college is getting upon the students is seen in two facts; first, the large number of its graduates who go into research in the universities—about one fourth choosing research as their profession, many of those going into medicine, for example, going in for medical research as well as medical practise, and this in spite of almost no encouragement to such research in the medical schools. There have also come complaints from some who have gone into law and engineering that there is no encouragement to and little opportunity for research in the schools giving training in these subjects. Indeed, there is in the country but one graduate school of engineering, and that is occupied as yet more with the sciences fundamental to engineering than with engineering itself. A second indication of the vitality of the students' interest in their work is shown by the fact that every year the professors have a good many graduating students coming to them in a difficult quandary because they

have developed so much interest in each of several subjects that they wish to go on to advanced study in each field though they know they must choose but one. And these subjects are in no larger proportion the sciences than the so-called humanities, a phraseology, by the way, which seems to me to have little, if anything, of real underlying distinction. College work which so grips the student that he wishes to go on to advanced study in several different lines is college work that counts. It is the sort of college work we should aim at. I have myself seen just this effect in one college, and I know from experience the deep satisfaction which the teacher has in working in such an institution.

But why have I told of this college and why have I used as title for this talk the phrase "Research and the American College?" Because of the effect which this type of college can have in the promotion of research both in its own work and in its stimulus to the work of other institutions. There has been for some decades in America an increasing emphasis upon research and there is now an increasing cooperation among scientists in attack upon research problems. The intricacy of interrelation between the sciences is becoming more clearly realized. The isolated student is helpless before many of the problems of greatest interest, and only the broadly trained student can appreciate his problems in their broader and more fundamental aspects. Scientific knowledge and its ramifications are so increasing and problems for solution are being disclosed in such great numbers that we need, and shall need, more and more research men of proper training.

It is this last phrase which defines the real theme of our discussion this evening—more research men, proper training for research. I believe that the key to the situation in America lies in the American college. It is in general true that if men are to turn to research as their life work they must receive their inspiration in the junior or senior year in college, and it is also true that university training, unless founded on college work of the right sort, can seldon properly prepare a man for worthy research. This is especially true because breadth of knowledge and catholicity of interest are essential to the soundest, strongest productive scholarship. The roots of research success penetrate deeper than the university into the soil of the college and from this source derive a great part of the nutriment necessary to growth of research. Inspiration and training are the words that focus the ideas that I have tried to present: inspiration to the choice of creative study as a life work and such training as will preserve and increase the student's initiative and ingenuity and independence.

Such inspiration and such training are not found to-day in the usual American college to any such degree as they should be. How can this condition be remedied? I believe a very practical initial step towards the desired result would be the securing, by transformation or by new foundation, of one or more colleges something such as I have described and letting them have their natural stimulating influence upon other institutions; colleges in which the number of students is small (no institutions have ever reached really worthy success in mass teaching), in which the number of the faculty is large, so that the teaching may be individual or with small groups, so that the teacher may do his own teaching work without dependence upon readers and unsupervised assistants and especially so that each teacher may have time and energy for his own research, and the teachers should all be thoroughly trained and worthy of professorial rank, except perhaps for experience in the cases of a few of the younger men. The two chief points are limitation of the number of students and increase in the number of the faculty, and this of course calls for large endowments. But success in any such attempt must come, if at all, from a realization of the value and importance of research.

What is research in the broad? Is it not the search for truth as to the realities in the midst of which we live and to which we must relate ourselves? And isn't this a fair half of the larger life? Search for truth, on the one hand, and loyal living of the truth, on the other hand. Isn't that about the whole of worthy life on its higher plane?

And in this search for truth the scientific method of observation and experiment is the real method. I would define science to include the whole field of testable reality, the realities of existence and relation which can be expressed in meters and grammes, and those realities in whose adequate expression qualitative descriptions must be used. All the realities in the midst of which we live and to which we must relate ourselves lend themselves to study by observation and experiment and call for such scientific research if we are to have an increasingly sound relation to them. Qualitative tests of truth are as valid as quantitative tests, though requiring a different type of exercise of judgment. Spiritual realities are as real as are material realities, and they very possibly are scientifically more fundamental, belonging to a substratum out of which material realities emerge. Trueness is conformity to reality, and beauty is a real criterion for testing the reality or falsity of relations in matters which for the lack of a less abused word we call spiritual. These definitions include, therefore, the whole field of college work in our discussion, no subject which deals with realities being omitted. Research in human life in all its aspects as well as research in chemistry and physics is needed: testing truth, testing realities of

relation, is needed in all fields if we are to be able properly to relate ourselves to the realities in the midst of which we live. Scientific research is no narrow thing. The scientific motive and the scientific method properly apply in all phases of human thought and action. The field is a vast one and its intricacies increase in geometrical ratio as our knowledge grows and our vision widens. Perhaps the phrase "productive scholarship" or "creative scholarship" would be less liable to misunderstanding than the word "research." I would use the three as almost synonyms.

In closing may I be allowed a word of caution against misinterpretation of the attempt to emphasize scientific research in college? This does not at all mean, as so many seem to think, emphasis upon the so-called utilities. So-called practical motives are a poor inspiration and an unsafe guide in research. Let me quote a paragraph from a former discussion of this theme:

> The motives to research may be as varied as are the characters and interests of the men engaged in the pursuit. But the urge which seems the most productive of the highest grade work is that of the fun of the game, the pleasure in the research itself, the love of truth and its pursuit. Ulterior motives of personal profit or even the desire to promote the progress of civilization and the well-being of society, all have an element of danger. They are likely to persuade the student, perhaps unconsciously, to control the direction of his search, turning it into so-called profitable channels. But no man can know where lie the great undiscovered truths. Truth itself is a safer guide into the unknown than is any man's guess as to the probable best line of approach to worth-while knowledge. The student who humbly follows where the subject itself seems to lead him, eager to follow whatever turn the investigation naturally takes, is the one most likely to find the richest deposits for his mining. Truth is too manifold, too unexpected, too great, oftentimes too profoundly simple, for any man's successful anticipating. From the most unexpected sources come discoveries that open great vistas far beyond the previous imagining of any man. The humble following of the subject itself and the suggestions that develop in the research is the method usually that brings to the largest results. Interest in the subject itself, the desire to know the truth, the pleasure, the uplift of soul, that comes with the gaining of some new vision into a hitherto unexplored field of reality, these are the safest guides, leading one to results in value far beyond fame or financial profit or some invention that shall increase the perhaps already too great complexity of human life. The instinct for truth, the love of understanding for its own sake is ingrained in the human soul.

And to it may safely be made the strongest appeal in inducing students to enter upon the life of research. The fun of the game, the worth of the game for its own sake, makes a keener appeal to men of the finest type than does the thought of possible dollars to accrue or possible fame to be attained.[2]

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[2] Several persons who have heard or read this paper in manuscript have referred to the college described as Utopian. It is really not so far removed from realization as one might think. In Oberlin College since 1836 the faculty have had complete control over educational policy and methods, over budget, over appointment of teachers and other members of the staff, and in reality, though not in legal form, have had as much determining influence as the trustees in choice of president. Oberlin's president functions not as an autocrat, but as chairman of faculty and trustees. Oberlin has a "Presidential Committee" composed largely of faculty members which is empowered to act for the trustees when the latter are not in session. Many colleges limit the number of their students. Five years ago when Oberlin received a gift of several million dollars the faculty voted that it should be the policy of the college to have more full professors than associate professors and more associate professors than instructors. She now has 51 full professors, 40 associate and assistant professors, 18 instructors (including gymnasium floor directors) and 7 laboratory and other teaching assistants. Numerous colleges encourage individual work for honors, mostly by seniors. Oberlin now has a committee considering increase of such individual work in the college. Swarthmore has no regular classroom work for honors students in the junior and senior years. Professor Hilton, of Pomona College, puts a good many of his first course students onto an original problem for about one quarter of their time and continues this method with more advanced students and with such success that the heads of the zoological departments of two universities have said to me that their best trained graduate students come from Pomona. For a good many years Goucher College never allowed her students to know anything about grades until after their graduation, though the registrar's records were kept in the form of grades. I am under the impression that no student ever made inquiry after graduation as to her grades. At least two colleges now keep for each student cards not only giving grades but annotated also somewhat as suggested in this paper. During the first 20 years of Goucher's work just 20 per cent. of her graduates went on to graduate study in universities requiring college graduation for admission. Half time teaching and half time for research is found, I think, only in a few collegiate departments of universities and in no independent colleges. The college pictured in this paper is a composite of features from a number of institutions but embodies no new feature except the combination itself.

ATOMIC NUMBERS VERSUS ATOMIC WEIGHTS

IN the first report of the International Commission on the Chemical Elements the following statements

occur: "A *chemical element* is defined by its *atomic number*." This statement serves as an example of the tendency among physical chemists to regard the order of arrangement of the elements as more important than the atomic masses which are so arranged. Their justification for this procedure is twofold. First, the atomic numbers are supposed to represent the number of electrons belonging to each elementary atom, and, secondly, the net electric charges carried by the atomic nuclei. Neither of these assumptions is absolutely proved, and much experimental work must be done in order to establish their verity. The atomic numbers may be changed by the discovery of new elements, or by the definite placing in the scale of atomic weights of such spectral elements as nebulium and coronium, which are now known only from their spectra in nebulae or in the sun. There is evidence to show that nebulium falls between hydrogen and helium, and that coronium is lighter than hydrogen; so that the placing of these elements would involve the renumbering of all the others. I cite here only one of the uncertainties that are connected with the atomic numbers; for present purposes I need not follow this line of discussion any further.

Now the value of any theory is best determined by its utility. Does it bring all lines of evidence into convergence? Does it assist in the solution of related problems? Does it point the way to new discoveries? All this has been done by the atomic theory, and in great part through the practical uses of the atomic weights. These are the fundamental data of chemical arithmetic. When we fix the chemical formula of a new compound, or from a formula we compute the quantitative composition of the substance that it represents, we use atomic weights. If we write the equation for a chemical reaction, no matter how complicated it may be, we still use atomic weights or symbols representing them. The atomic numbers do not help us, for they have no bearing upon these very common problems. For the atomic weights of the elements *and* their numerical order the periodic law was developed, but the weights came first. The physical properties of the elements were then found to be functions of the atomic weights, but the functions were often, if not always, periodic, and not determined by or directly related to the quantities which we now call the atomic numbers. In the Lothar Meyer curve of atomic volumes this periodicity is clearly shown, and the elements fall into natural groups regardless of their atomic numbers. The atomic volumes represent the ratios between the specific gravities of the elements and their atomic weights. The similar curves of melting points and of compressibilities also represent ratios in which the atomic numbers do not appear. The superior utility of the atomic weights is evident. Even the atomic numbers and the physical quantities that are directly related to them may be interpreted as functions of the atomic masses. If so much be admitted, then a chemical element should be defined by the aggregate of all its properties.

So far the argument is strongly in favor of atomic weights, but are they definite constants? Or are they merely "statistical averages" of nearly related but not identical quantities? The problem is complicated by the existence of isotopes, and their true nature is as yet incompletely determined. Are they all to be classed together, or do they fall into two or more different classes? The time is not yet ripe for a complete answer to these questions, but some evidence bearing upon them is even now available. In the study of radioactivity it has been found that two elements, uranium and thorium, are spontaneously but slowly decomposing and probably have been doing so for many millions of years. This process of decay ends, so far as we now know, with the production of two varieties of lead, one from uranium as its ancestor, the other from thorium. The atomic weight of uranium lead is approximately 206; that of thorium lead is about two units higher. These atomic weights have been directly determined with material derived from ores of uranium and thorium. Between these varieties of lead and their ancestral elements, four other decomposition products have been identified with hypothetical atomic weights ranging from 210 to 214, and all six of these products are given the same atomic number with ordinary or normal lead, and are regarded as isotopic with it. That is, they are assumed to be chemically identical with normal lead, and not separable from it or from one another by any purely chemical process. That they have not been so separated is true, but to say that such separation is impossible is to go beyond the evidence. The history of science contains many instances of impossibilities that have become possible. Ordinary lead, which I believe to be the normal or stable product of elemental evolution, has an atomic weight of 207.2, as determined by Baxter and Grover with samples derived from four different ores, and from localities as widely separated as Missouri and Australia. This value is definite, and is the one which, rounded off to 207, is used in chemical calculations. It is hard to believe that so constant a figure can be a mere statistical average of values ranging from 206 to 214, or even from 206 to 208.

Now these isotopes of lead, with numerous other products of radioactivity, are assigned atomic weights and numbers which are largely hypothetical. For uranium lead and thorium lead the atomic weights have been actually determined, and the same is true for radium, and less exactly for its emanation. Ionium is known to have a lower atomic weight than thorium, but the other "elements" of this group have

had their constants fixed by reference to those of their ancestors. The atomic weight of uranium as we know it is that of an element which is slowly decomposing, and has been doing so for millions of years. The atomic weight of normal uranium, as the element was before it began to decay, is unknown. Conditions of which we know nothing favored its evolution; when they passed the element became unstable and decomposition began. Our existing uranium is not the same as it was at the beginning; it is a mixture of undecomposed atoms with some products of decomposition, among which may be substances that are not giving off radiations and are not likely to be detected easily. This, I admit, is speculation, which may or may not be sustained by future discoveries. The essential fact is this: that the radioactive elements are products of decomposition, and their atomic weights and numbers as derived from those of uranium and thorium, two partially decayed elements, can not be exact. The derived "elements" are themselves decaying, some slowly and others rapidly, some of them with life periods of many years, some with their existence limited to fractions of a second. They are matter in transit from one form to another; and how far they are entitled to be called elements is yet to be decided. They can not be defined by indefinite atomic numbers.

So much for the radioactive elements and their isotopic relations. It is not necessary for present purposes to consider them in greater detail. What, however, can be said of the elements below lead in the scale of atomic weights? Here the study of "mass-spectra" by Aston is extremely suggestive. These spectra, as recorded on carefully calibrated photographic plates, may be divided into two classes: first, those giving single lines, and, secondly, those in which the record is multiple. By the relative position of these lines upon the plates the atomic weights of the elements giving them are approximately determined, and all are found to be near whole numbers when $0 = 16$ is taken as the standard of comparison. That standard, however, was originally adopted by chemists as a matter of convenience, and has no philosophic background.

The elements giving single line spectra are defined by Aston as "simple" or pure elements, not complicated by the presence of isotopes. Their atomic weights, therefore, are definite quantities, and not statistical averages. Those giving double or multiple spectra are supposed to be mixtures of isotopes. Up to the time of writing, or rather of the latest published report seen by me, 23 elements have been defined as simple, or about half of those that have been investigated. What is the meaning of the others? The isotopes revealed by radioactivity are, as we have seen, decomposition products; are those of the mass-spectra of the same character? Or are the mass-spectra due to impurities too small in amount to be detected by other means? Or do the multiple spectra represent clusters of similar, but slightly different atoms which reveal their differences on the photographic plates? That is, as Aston maintains, are the elements giving these spectra mixtures of isotopes?

In the report of the International Commission, pp. 9 and 11, is given a table of isotopes that is extremely suggestive. The simple or pure elements, so far as they have been identified, are, with few exceptions, all below atomic number 40. Eight of them do not appear in the table, for they were discovered by Aston since it was published. Iodine and caesium are also simple elements; but, as we ascend in the scale of atomic weights, the isotopes tend to become more common and more numerous. I speak of a tendency, not of a definite rule. Although doublets and triplets appear in the lower part of the scale, that is, among the elements of structural simplicity, we can say that the more complex an element is, the probability of the appearance of multiple mass-spectra becomes greater. Not until all the elements have been studied by Aston's method can any definite rule as to isotopes be formulated. Among the radioactive elements or pseudo-elements isotopy seems to be the rule. "Simple" elements have not been found among them. In this region isotopy is definitely associated with atomic instability. Is it not, therefore, legitimate to suppose that some of the multiple mass-spectra may indicate elemental decomposition? Along this line of thought, however, we must not go too far. Two elements, chlorine and mercury, need separate consideration, and there may be others like them.

Consider first the two elements as we know them, that is, as they occur in nature. The atomic weight of chlorine is very constant, and the value assigned to it is 35.46 within 1 part in 10,000. That of mercury is very close to 200.6, and its definiteness is also fixed by determinations of its density. Brönsted and Hevesy determined the specific gravity of mercury from ten different sources, and only found differences corresponding to differences in atomic weight of from 0.0004 to 0.0012. The ten samples were identical within the limits of experimental uncertainty. The same chemists, however, by a process of fractional evaporation, succeeded in partially separating mercury into two fractions which differed in density and also in atomic weight. The atomic weight determinations were made on the original fractions by Hönigschmid and Birckenbach, who found for the heavier fraction $Hg = 200.628$; and for the lighter one $Hg = 200.562$ to 200.568. These figures are conclusive; and although the fractional separation was not absolutely complete, they prove the composite character of mercury. Similar results, by a similar

method, have been obtained by Harkins and his colaborers in Chicago. According to Aston, the mass spectrum of mercury shows two lines at 202 and 204, with four others of uncertain significance between 197 and 200. These figures, it seems to me, are questionable, for 197 is the atomic weight of gold, and 204 that of thallium. Did the mercury studied by Aston contain as impurities minute traces of gold and thallium?

By prolonged fractionation Harkins has divided hydrochloric acid into two portions which differ in atomic weight and density, thus showing that chlorine, like mercury, is composite. But for neither element has the separation of its components been complete. That one component is more massive than the other is clear, but the definite atomic weights of the two elements show a constancy of composition which calls for explanation. We are not dealing with indefinite variable mixtures.

I now venture to offer a hypothesis which is at least fairly plausible. In the evolution of the elements some of them were generated as doublets in which the components are loosely held together, but which in their chemical relation act as units. We can conceive of such doublets as analogous to double stars, those pairs of suns which move and act together, notwithstanding their differences in mass. Whether this analogy can be extended to the elements that give multiple mass-spectra remains to be seen. About half of the known elements are yet to be studied by Aston's methods, and the work is being carried forward energetically. When it is finished we may hope to know much more as to the relative significance of atomic weights and atomic numbers, and as to the real nature of the chemical elements.

Frank Wigglesworth Clarke
U. S. Geological Survey

MATHEMATICS AND GEOPHYSICS[1]

Geophysics is physics applied to the study of terrestrial phenomena. To make the statement more definite it may be of interest to enumerate the subdivisions of this science as formulated by the National Research Council in organizing the American Geophysical Union. That union includes sections of: (1) Geodesy, (2) oceanography, (3) meteorology, (4) seismology, (5) terrestrial magnetism, (6) volcanology and (7) geophysical chemistry.

To the student of geophysics, as to the student of physics in the narrower sense, there are open three ways for discovering truth: (1) Observation of phenomena under controlled conditions, in short, laboratory experiments; (2) observation of phenomena as they are presented to us by nature; and finally (3) logical deduction from assumptions suggested by observation and experiment and comparison of the conclusions reached with the observed facts. The most satisfactory method of deriving our conclusions is by mathematical reasoning, since this method alone gives quantitative results.

From the nature of the case the methods of laboratory experiment have been of less use in geophysics than in physics in the narrower sense. The experimenter can reach only a few miles into the upper air with his pipes and balloons carrying their recording apparatus and must himself remain on a still lower level. Our deepest borings penetrate but a few thousand feet into the outer skin of the earth[2] and the interior of the earth still remains, as has been well said, the playground of the imagination, almost as much so as when Dante peopled it with the spirits of the departed.

It would, however, be unfair to insist on this thesis of the comparative inapplicability of laboratory methods to geophysical problems without mentioning the work of the Geophysical Laboratory, a department of the Carnegie Institution, which is in fact applying laboratory methods to these problems and applying them with marked success. Still, with every allowance of this sort made, in geophysics the methods of the physical laboratory can do little for us in comparison with what is possible in other sciences.

Therefore, in geophysics we must depend all the more on the observation of those phenomena directly presented to us by nature and on mathematical reasoning. A striking example of this method or combination of methods is found in recent progress in our knowledge of that still mysterious region just referred to, the interior of the earth. Important advances have been made which I shall not attempt to set forth by combining the observations at earthquake stations all over the globe and applying to these observations mathematical methods of rather recent development, the theory of integral equations.

Now it would be impossible for any one person to discuss satisfactorily all the problems in geodesy, seismology, oceanography, etc., in which mathematics has given aid, or which still await the hand of him who shall apply existing mathematical methods to them, or who, if need be, shall devise new methods.

[1] Read at the summer meeting of the Mathematical Association of America at Poughkeepsie, N. Y., September 5, 1923.

[2] The greatest authenticated height reached by a sounding balloon bearing instruments is 35 kilometers. A pilot balloon without instruments is reported to have reached the height of 39 kilometers, but this record is open to doubt (information supplied by U. S. Weather Bureau). The deepest boring in the world is at Fairmont, West Virginia. The depth is 2310 meters (7579 feet) (information supplied by U. S. Geological Survey).

And even if the whole corps of specialists necessary for such an exposition were present here, the entire time allotted to this meeting would be far too little even for the baldest of treatments, so I shall confine myself to a few statements chiefly about two general subjects which may perhaps be of interest to teachers: (1) The use that may be made of comparatively elementary methods and (2) numerical calculation.

Before entering on these two matters it may be pertinent to make the obvious remark that the mathematical treatment of geophysical problems is included in the treatment of the problems of general mathematical physics. It may also be pertinent to ask why mathematical physics has been so little studied and developed in this country, so little, that is, whether we base our comparison on the attention given to the allied subjects of pure mathematics and experimental physics, or whether we base it on the attention given to mathematical physics in the countries of Western Europe. I ask the question, but do not attempt to answer it, for one reason because I can not do so satisfactorily, and must, therefore, leave the answering to you.

The use of elementary mathematics is rather in clearing the ground of unprofitable speculations that hinder the advance than in making the advance itself. Speculation has been uncommonly rife in geophysical fields, and those who have put forward suggested hypotheses have not always deigned to test them even by rough and easy calculations which might have shown their untenability and thus saved the time of hearers, editors, typesetters and readers. It is frequently as easy to set rough numerical limits which will show whether or not an idea is worth pursuing further, as it is difficult to work out an accurate theory. It is evident that according to the law of gravitation it will make a difference in what happens on our earth according as some hypothetical inhabitants of the planet Saturn do or do not build a subway there, but it will be granted without much calculation that we do not need to care, as far as any effects that we can now detect may go, whether or not they build a whole system of subways. Now in geophysical speculation some of the causes suggested have been about as inadequate to the effects as the Saturnian subways would be to explain variations in our terrestrial climate.

As a recent example, take the Wegener hypothesis of the migration of continents or rather one explanation of this migration. According to the Wegener theory a continent is not securely fastened to its foundations, but is capable of moving as a whole, much as an iceberg moves through the surrounding water. The motion is in general westward. Now there is a very minute force which might—I doubt whether in fact it does—displace such a continental mass, not westward but towards the equator. The rate of motion would be at most a few inches or a few feet a year. Now Wegener suggested that such an equatorward force together with the deflecting force of the earth's rotation might produce the postulated westward motion of the continents, just as the equatorward currents of air are deflected by the rotating earth and give rise to the westerly component of the trade winds.

The importance of a rather high equatorward velocity such as the air currents have and the continents have not, even on the most favorable supposition, seems to have escaped Wegener. It is only fair to add that this absurdity was removed in a later edition of Wegener's book, but not before it had inspired a very similar absurdity. A reader of Wegener reasons thus: A falling body is deflected towards the east and if it fell down a narrow vertical tube, it would press against the eastern wall of the tube. By analogy, therefore, a mass of rock slowly sinking would press against the eastern side of the rocks surrounding it or a slowly rising mass of rock press towards the west. True enough qualitatively, but if we consider the rate at which rocks rise or sink, the utter unimportance of the effect is easily proved. Yet this suggestion was put forth in good faith and reproduced in good faith in the pages of scientific journals of standing.

A consideration of the dimensions of the quantity aimed at is a useful check on algebraic work and the application of it may save one from humiliating blunders. One author, discussing the possible effect of variations of latitude in producing earthquakes, makes a "howler" in the fundamentals of his calculus for which a sophomore would deserve to be called down sharply. Yet even so, he might have sensed that something had gone wrong and so saved himself if he had only examined the dimensions of his result and noticed that his expression for the intensity of stress was of the wrong physical dimensions.

These remarks apply equally well to many subjects other than geophysics. It is a question quite as much of mental attitude as of any mathematical rule or theory. What I shall now say about numerical computation is of almost equally general application.

It has long seemed to me desirable that more attention should be paid in our mathematical courses to numerical computation. In geophysical work, dealing as it does with vast masses of data, this is especially desirable. Yet our mathematical curricula are already overcrowded and it is not easy to see where a place could be found. Furthermore, text-books in English are almost totally lacking. Perhaps a well-written book on the subject might draw enough attention to the importance of the subject so that it would be more generally taught.

I should like to see such a book that would set forth on the elementary side the best arrangement of work, the accuracy desirable and attainable in any given process, short cuts, rough approximations and rough checks and on the more advanced side, in the use of differences, interpolation, mechanical quadrature, numerical solution of equations, calculations with infinite series.

Even more advanced topics might be introduced, but that question involves another aspect of numerical calculation about which I wish to say a few words in closing. The solution of problems for mathematical physics in general, and of many problems in geophysics in particular, are often satisfactory enough from the purely analytical point of view, but rather unsatisfactory from the point of view of numerical calculation. It would be desirable if mathematicians would think more of this aspect of the question, for, after all, the final test of a theory is numerical comparison with the results of observation. The book on numerical computation of which I have spoken might contain as a second part a discussion of the numerical solution of differential equations, of integral equations, of the treatment of series that converge for the pure mathematician, but not for the practical computer, in short, a number of topics continually increasing as our mathematical theories develop. The easiest way to have such a book kept up to date would be for each mathematician who develops a theory that leans in any way towards practical application not to leave the analysis until he has considered the question of putting his formulas into numbers by the easiest and safest way.

These remarks can be summarized very briefly: Geophysics involves mathematics to a greater extent than do most physical sciences. Elementary mathematics is involved because of the extensive tabulations and numerical computations that are required. Even elementary mathematics, judiciously used, may serve to check the vagaries of an over-active imagination and to warn the inquirer off paths that lead nowhere, except perhaps to confusion. Advanced mathematics is needed, not merely because geophysics is a part of mathematical physics in general and has given rise to many interesting mathematical problems, but chiefly because geophysics is peculiarly dependent on mathematical methods.

W. D. LAMBERT

U. S. COAST AND GEODETIC SURVEY

SCIENTIFIC EVENTS

THE LONDON MUSEUM OF SCIENCE AND TECHNOLOGY

THE resolution given below in regard to the London Museum of Science and Technology has been adopted by the Royal Society, the British Association for the Advancement of Science, the British Science Guild and about thirty other scientific societies of Great Britain, and has been submitted to the Board of Education:

We the undersigned, being deeply interested in the progress of science and in its application to industry, desire to bring to the notice of H.M. Government the inadequacy of the accommodation provided for the collections at the Science Museum, and the disadvantages resulting to science and technology therefrom. Several committees have reported on the Science Museum, notably in 1874, 1884, 1889 and 1912, and all of them have emphasized the importance of the collections and the value of the assistance which they can give to science and industry; they have also commented on the unsatisfactory character of their accommodation; to-day the Science Museum is still the only national museum housed in buildings most of which were neither designed nor constructed for museum purposes.

The collections which illustrate the development of science and of large and important branches of technology are in some respects unique. They include many selected examples of modern practice and are of the greatest value to students as well as to investigators and all who are concerned with these departments of knowledge, but they can not be fully utilized for consultation and study in the crowded and insufficiently lighted galleries where they are now displayed, while the risk from fire is very great.

The Departmental Committee which reported in 1912 considered that a total of 265,000 square feet of exhibition space was immediately necessary, which should be increased subsequently by an additional area of 287,000 square feet. They sketched out a plan for a building in three blocks, and recommended that the immediate need should be met by the erection of the Eastern and Central Blocks. We understand that the work at present authorized will bring the exhibition area up to a total of 120,000 square feet only, or less than one half of what the Committee recommended, and only about 30,000 square feet in excess of that now available.

We venture, therefore, to urge upon H.M. Government the importance of completing the whole of the Eastern Block of the new Science Museum building forthwith, thus raising the space available for exhibition to 180,000 square feet, and since this will not provide all the space which was considered immediately necessary in 1912, of preparing plans for a central block as soon as possible.

STANDARDIZATION IN GERMANY

STANDARDIZATION of industrial production has been one of the important factors in enabling Germany to maintain its industrial machine intact, in the face of the obstacles now confronting that country, according to a bulletin by Dr. P. G. Agnew, secretary of the American Engineering Standards Committee, recently issued by the American Engineering Standards Committee. Dr. Agnew recently returned from Europe,

where for two months he made a study of the standardization movement and the manner in which European developments in this direction are likely to affect American industry.

He reports that the elaborateness of the organization for the work, its activity and the scale on which it is being carried out constitute a new development in industrial organization. Practically every important manufacturing concern in Germany is officially participating in the industrial standardization program of that country. More than a thousand German companies have formal standardization organizations within their own works.

The extent to which industrial life has been coordinated is shown by the fact that more than seven hundred national standards have been adopted. This includes only those in which several different industries are concerned, and which are approved by the central national body. In addition to this work of the central body, and closely correlated with it are no less than sixty-five special industry committees actively working on the subject.

A striking example is cited of the efficiency of national standardization as it has been developed in Germany, in the case of a rush order placed with German manufacturers for 200 locomotives for delivery to Russia. "Production of different parts was allotted to seventeen different manufacturers to be produced strictly upon the plan of interchangeable parts, no one manufacturer making a complete locomotive. No serious practical difficulty was encountered in filling the order. The inspectors made a test of the feasibility and accuracy of the plan by ordering a complete locomotive to be assembled from parts chosen at random from those furnished by the seventeen manufacturers. It proved to be ready for service immediately after assembly without the necessity of any disassembling for readjustment."

Standardization engineering is now a recognized profession. An interesting development of the last few years is the appearance of consulting engineering firms specializing in this work. There are now five such firms in Germany. The work is closely connected with industrial or efficiency engineering, in which there is a great and growing interest.

BAYER 205

As has been reported in SCIENCE, Professor F. K. Kleine, of the Robert Koch Institute of Infectious Diseases, Berlin, who has just returned to Europe, has been investigating the therapeutic properties of a drug known as "Bayer 205" in Rhodesia and the Congo in cases of human sleeping sickness and trypanosomiasis of domestic animals. *Nature* writes as follows: "It is well known that salts of arsenic and antimony are able in many cases to control these diseases, but these remedies are far from satisfactory, and the remarkable results which were reported in Germany in 1922 in the treatment of experimental trypanosomiasis in animals and in dourine of horses with the new drug 'Bayer 205,' the composition of which has not yet been made public, aroused much enthusiasm. The completely satisfactory treatment of a human case in Hamburg, after arsenic and antimony had failed at the Liverpool School of Tropical Medicine, excited considerable interest. Other patients were treated at the London School of Tropical Medicine, and it became evident that in many cases the drug had a rapid action on the trypanosomes, and, so far as can be said at present, has effected a permanent cure. The one disadvantage is a certain irritative action on the kidneys, which, however, is not of a permanent nature. Professor Kleine was granted permission by the British Government to conduct experiments in Rhodesia, and the published accounts of his work show that the hopes which were entertained were fully justified, and that cures can be effected in a large percentage of natives suffering from sleeping sickness even in its advanced stage. As regards the trypanosomiasis of domestic animals, he has noted that it is only efficacious in ridding them of trypanosomes which are most closely related to those which produce disease in man. Experiments on the prophylactic action have shown that if cattle which are to be exposed to the bites of tsetse flies are given an injection of the drug before exposure, the chances of infection are reduced, and even if infection does occur its course is considerably modified. It is understood that Professor Kleine will, in the near future, give an account in London of his experiences."

THE METRIC STANDARDS BILL

AMONG the first bills introduced in the new session of the Congress are the Metric Standards Bills, providing for gradual adoption of the metric units of weights and measures in merchandising.

The metric bill was introduced in the House of Representatives by the Honorable Fred A. Britten, of Illinois, and in the Senate by Honorable Edwin F. Ladd, of North Dakota. The legislatures of these states, in company with many others, have petitioned the Congress to enact metric standards laws. More than 100,000 petitions, directly representing several millions of voters, are pending before the Congress, urging favorable action on adoption of the world units for weighing and measuring.

The simple decimal nature of the metric system is ingeniously stressed in the numbers of the metric bills themselves, Congressman Britten's being number 10 in the House and Senator Ladd's bill number 100 in the Senate.

According to the provisions of the Britten-Ladd bill, the buying and selling of goods, wares and merchandise will be in terms of the metric units after a period of ten years. Manufacturers are to use whatever measures they choose in production, the bill providing "That nothing in this act shall be understood or construed as applying to the construction or use in the arts, manufacture or industry of any specification or drawing, tool, machine, or other appliance or implement designed, constructed or graduated in any desired system." This safeguards manufacturing interests. Hundreds of great industrial concerns are urging the metric legislation on this basis.

Rules and regulations for the enforcement of the metric act are to be made and promulgated by the United States Secretary of Commerce.

THE SECRETARY OF AGRICULTURE ON THE WEATHER BUREAU

IN his report of the Weather Bureau operations during the last year, presented to Congress, Secretary Wallace, of the Agricultural Department, says:

A new significance is attached now-a-days to the weather factor in all human conduct and operations. For centuries a topic often convenient to fill lulls in conversation and for other purposes, the present and prospective weather for a continent, almost for the whole world, is now spread before the public twice a day in all the newspapers, weather maps and a multitude of bulletins and advices.

The United States leads the world in the utility, practicability and extent of this public service, and even the smallest progressive nation recognizes that an organized public weather service is now quite as much a necessity as, say, a postal service or a police force. This is a growth and development of the last fifty years.

In the United States the general public takes the work of its Weather Bureau more or less as a matter of course. In early years its forecasts and prognostications were not taken very seriously, and its popular sobriquet of "Old Probabilities" was suggestive of the humorous estimate in which its work was generally held.

Recognizing its limitations, undismayed by the onslaught of its critics, confident of the wonderful possibilities of its useful public service and its ability to make it worth while to the nation—to make its work pay back to the nation in economic benefit many hundreds of dollars for one expended on the maintenance of the work—the bureau struggled on, bettering and extending the service little by little and in many ways.

Every paper carries the message of present and prospective weather, and for those who need fuller details special bulletins convey everything known and ascertainable.

The shippers of perishable foods and products are told of the hot and cold waves their shipments will encounter en route to any destination. To the great centers of population this foreknowledge permits the saving of many thousands of dollars annually in losses either of products or by damage claims, or both.

Severe cold waves, heavy snows and general storms are forecast well in advance, and livestock is sheltered, provisions made for maintaining traffic, snows removed without embarrassing blockades, and every precaution taken to minimize the ill effects which would overtake every community visited unawares by these atmospheric phenomena.

Orchards are protected from frosts, and fruits and agricultural crops are saved.

In the flooded areas of the great waterways advices are given many hours, often days, and sometimes weeks in advance of the crest stages, generally to the fraction of a foot, which the flood will attain.

Only the merchants, the engineers in control of river operations and the agriculturists whose acres are subject to possible inundation are able to speak from personal experience of the accuracy and value of the flood warnings of the bureau.

On the Great Lakes vessels are often compelled to make shelter or tie up at dock during stormy conditions. It has been stated that any delay of this character entails an economic loss of from $50 to $100 per hour per vessel. Ignorance of the status and progress of such storms on the part of the navigators leads to an embarrassing dilemma. To leave shelter too soon is to incur hazard of storm damage. To delay unnecessarily is to suffer excess of per hour loss. The local official of the Weather Bureau steps in at this point and with his command of the weather situation he is able to broadcast advices to shipping which literally save many hours of ships' time with practically no losses in safety and security.

With the advent of the practical navigation of the air a whole new service is now demanded, a service of flying-weather forecasts and weather advices to aviators. This compels the bureau to extend its observations and measurements above the surface into the free air, which is being done in a very limited way at the present time by means of kites and little so-called pilot balloons.

THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

THE fortieth anniversary of the American Institute of Electrical Engineers will be celebrated at the annual meeting which will be held in Philadelphia from February 4 to 8. The meeting is expected to be of unusual interest and importance.

By wire and radio from Chicago, Boston, New York and Washington, President Markham, of the Illinois Central; President Maher, of the Norfolk & Western; President Budd, of the Great Northern Railway, and Vice-president Buckland, of the New York, New Haven & Hartford, on the evening of Tuesday, February 5, will address a nation-wide audience in addition to those gathered in the Metropolitan Opera House in Philadelphia.

On Monday evening, February 4, the story of the development of a profession which started only forty

years ago and now ranks in accomplishment and influence with any in existence will be told. Members of the small group of electrical engineers who formed the pioneer organization of the institute will speak. Elmer Sperry, Elihu Thomson, T. C. Martin and J. J. Carty will address the meeting. These addresses will be followed by the presentation of the Edison medal to John W. Lieb.

The new Moore School of Engineering of the University of Pennsylvania will be dedicated on the afternoon of February 6, when members of the institute will be the honorary guests of the school.

In all nine technical sessions will be held, at which more than forty papers will be presented and discussed. These will cover transmission, superpower, industrial applications of electricity, electrical machinery and electrophysical subjects.

A trip is planned for Friday afternoon to the works of the Bethlehem Steel Company. Afterwards the visitors will be entertained at Lehigh University as guests of the Lehigh Valley Section of the Institute.

The social aspects of the meeting have been well provided for, reaching their climax in the annual dinner-dance on Thursday night. Headquarters will be at the Bellevue-Stratford Hotel.

SCIENTIFIC NOTES AND NEWS

THE prize of $1,000 offered by a member of the American Association for the Advancement of Science for a notable contribution to science reported at the Cincinnati meeting has been awarded to Dr. L. E. Dickson, professor of mathematics at the University of Chicago, who has developed a far-reaching general theory of the arithmetic of any rational algebra. The titles of the papers read by Professor Dickson, at Cincinnati, were: "Algebras and their arithmetics," "On the theory of numbers and generalized quaternions" and "Quadratic fields in which factorization is always unique."

THE Bôcher memorial prize for mathematical research was awarded at the New York meeting of the American Mathematical Society to Professor George D. Birkhoff, of Harvard University, for his memoir on "Dynamical systems with two degrees of freedom."

DR. L. O. HOWARD, chief of the bureau of entomology of the Department of Agriculture, has been awarded the cross of chevalier of the legion of honor by the French government in recognition of his services to world agriculture.

MAJOR GENERAL GEORGE O. SQUIER, head of the Signal Corps, United States Army, since 1917, was retired from active service, on December 31, at his own request.

DR. A. PARKER HITCHENS, of the Army Medical School, Washington, was elected president of the Society of American Bacteriologists at the twenty-fifth annual meeting, held at Washington. Professor Huntoon Harris, Queen's University, Kingston, Ont., was elected *vice-president*; Dr. J. M. Sherman, Cornell University, *secretary-treasurer*, and Dr. E. B. Fred, University of Wisconsin, and Dr. I. C. Hall, University of California, *members of the council.*

DR. MORRISON R. VANCLEAVE, superintendent of nature study in public schools of Toledo, was elected president of the American Nature Study Society at the recent Cincinnati meeting.

PROFESSOR S. I. BAILEY, of Harvard University, returned on December 29 after two years absence at the Harvard Observatory at Arequipa, in Southern Peru, where he studied problems relating to observations of the southern sky.

TEMPORARY appointments to the staff of the Peking Union Medical College have been made as follows: Dr. L. Emmett Holt, clinical professor of the diseases of children, Columbia University; Dr. C. U. Ariëns Kappers, director of the Central Dutch Institute of Brain Research in Amsterdam; Dr. William T. Councilman, Shattuck professor of pathologic anatomy, Harvard Medical School; Dr. Adelbert Fuchs, clinical professor of ophthalmology at Vienna, and Dr. William W. Cort, associate professor of helminthology, School of Hygiene and Public Health of the Johns Hopkins University.

PROFESSORS J. J. ABEL, of the Johns Hopkins University; M. H. Roger, dean of the Paris medical school; S. Recasens, dean of the Madrid medical school, and Lustig, of Florence, were recent visitors at Buenos Aires. During their stay Professors Abel and Roger were appointed honorary members of the biologic society, and Professors Roger and Recasens were made members of the academy of medicine. A special session was held by the academy as a tribute to Ramón y Cajal.

AT the meeting in New York of the American Mathematical Society, officers were elected as follows: *Vice-presidents* for one year, Professor E. V. Huntington, Harvard University; for two years, Professor T. H. Hildebrandt, University of Michigan, and Professor J. H. M. Wedderburn, Princeton University; *secretary* for two years, Professor R. G. D. Richardson, Brown University; *treasurer* for two years, Professor W. B. Fite, Columbia University; *librarian* for three years, Professor R. C. Archibald, Brown University. President Oswald Veblen's term expires in 1924.

DR. GEORGE H. BIGELOW, director of the Pay Clinic of the Medical School of Cornell University, son of

DR. ENOS H. BIGELOW, president of the Massachusetts Medical Society, has been appointed to the position of director of the Division of Communicable Diseases in the Massachusetts State Department of Public Health.

DR. JAN METZELAAR, lately fishery expert of the Holland Bureau of Fisheries, has accepted a similar post in the State Commission of Michigan, at Ann Arbor.

PROFESSOR NELSON C. BROWN, head of the department of wood utilization at the State College of Forestry, Syracuse University, has been granted a year's leave of absence. While in New York he inaugurated a campaign for an endowment fund for the American Forestry Association.

DR. REINHARD BEUTNER, formerly with Rockefeller Institute for Medical Research and later at the University of Leyden, Holland, is now with the Combustion Utilities Corporation at its laboratories at Long Island City, N. Y.

THE annual address of the Sanitary Division of the American Society of Civil Engineers will be given at a dinner held at the Hotel McAlpin, New York City, on January 15, by Professor George C. Whipple, of Harvard University. His subject will be "Sanitation—its relation to health and life."

DR. DAVID MARINE, director of laboratories of Montefiore Hospital, New York City, will deliver the fourth Harvey Society Lecture at the New York Academy of Medicine, on Saturday evening, January 19. His subject will be "The etiology and prevention of simple goitre."

A SYMPOSIUM on catalysis will be the chief topic of the meeting of the New England Section of the American Chemical Society to be held at the Massachusetts Institute of Technology, on January 12. Professor Wilder D. Bancroft, of Cornell University, will preside and present the opening paper. Professor Hugh S. Taylor, of Princeton, will speak on "Negative catalysis," Dr. Alfred T. Larson, of the Fixed Nitrogen Research Laboratory, Washington, D. C., on "Ammonia catalysis," Professor Colin G. Fink, of Columbia University, on "Catalytic electrolytic generation of oxygen," and Professor James F. Norris, of the Massachusetts Institute of Technology, will discuss "Certain new catalytic effects of zinc and aluminium chlorides."

SIR WILLIAM BRAGG gave, on December 27, the first of the Christmas series of juvenile lectures at the Royal Institution, London, on "The atoms of which things are made."

DR. OTTO KLOTZ, director of the Dominion Observatory, died at Ottawa, Canada, on December 28, aged seventy-one years.

DR. J. H. HAMBURGER, professor of physiology in the University of Groningen, who lectured in the United States in 1922, died on January 4, aged sixty-four years.

THE death is announced at Paris of Gustave Eiffel, the engineer who built the tower that bears his name.

ON December 21, the name of "The Thompson Institute for Plant Research, Inc.," was changed to "Boyce Thompson Institute for Plant Research, Inc." This was done for the purpose of making evident in the name that Colonel William Boyce Thompson founded and endowed this institute as a memorial to his mother and father.

MRS. ANDREW TODD MCCLINTOCK, widow of Dr. McClintock, of Wilkes-Barre, Pa., has created a trust fund of her estate, amounting to approximately $500,000, to be known as the "Andrew Todd McClintock Memorial," to be used to conduct researches into the nature, causes and treatment of gastro-intestinal troubles. The only provision made in the endowment is that she retains a life interest in half of the income. A research agency is appointed and provision is made for carrying on the work perpetually.

A PART of Rancho La Brea, including the famous Brea Pits, from which many remains of the Paleozoic age, among them 600 saber-tooth tigers, have been removed, has been given to Los Angeles County by G. Allen Hancock, its present owner, to be made into a public park. The property faces for approximately half a mile upon Wilshire Boulevard, in an outlying section of the city, which within the last few months has begun to be built up into a residential district. It was stipulated by the donor that the county board of supervisors expend $25,000 within a year in improving the land and laying the foundations for a permanent public park.

HENRY J. LOFTUS, of London, has made a gift of two hundred and fifty acres of land in Virginia to Buchtel College. This land adjoins the tract recently given the university by Dr. James S. Swartz, of New York City. It is situated in Fairfax County, between Washington, D. C., and Mount Vernon.

THE Forestry Commission has set apart an area in the Glenbranter Forest estate, between Loch Fyne and the Firth of Clyde, as a permanent memorial to Sir Isaac Bayley Balfour, who for 34 years before his death, in 1922, was Regius Keeper of the Royal Botanic Garden at Edinburgh, and rendered signal service to the cause of botany, horticulture and arboriculture. With the cooperation of the Office of Works, it is proposed to plant the area with Asiatic rhododendrons and other trees, shrubs and plants

propagated in the Royal Botanic Garden at Edinburgh in which Sir I. Balfour was especially interested. It has also been proposed by some of Sir Isaac's friends to erect in the memorial area a modest rest-house dedicated to his memory, where students and others interested in the various families may study them at first hand and under what will amount to natural conditions. In connection with this, a memorial committee, with Sir John Stirling-Maxwell as chairman, has been formed at 25, Drumsheugh-gardens, Edinburgh.

IT is officially announced that the International Council for the Exploration of the Sea, which met in Paris last month, has decided to carry out a scientific investigation of the fisheries of Iceland and the Faroes. Much of the work will be carried out by means of the Danish research ship *Dana*, and operations will extend from the neighborhood of Iceland to the north of Norway. Hydrographical-biological cruises will also be undertaken from the west of Scotland to the Faroes. British trawlers are predominant in the fishing in the region concerned, and the investigations contemplated are of considerable importance to Great Britain. The council also decided to support a proposal put forward by Professor Otto Pettersson and Commodore C. F. Drechsel for an international expedition to study the system of currents of the oceans, with special reference to the relations between changes in these currents and changes in the fish life of the seas. It was considered that such an investigation could best be begun by a preliminary expedition lasting about four years, which would cost £30,000 to £35,000 a year, in addition to the cost of acquisition of a suitable ship.

DR. ROY WALDO MINER, curator of the department of lower invertebrates of the American Museum of Natural History, has returned from a trip to the Bahama Islands in the interests of a new exhibit planned for the Hall of Ocean Life of that institution, now in the course of construction. This exhibit is to show a twenty-five foot section of a coral reef as it appears under its natural living conditions in the wonderful coral lagoons of Andros Island in the Bahamas. Along the shore of the island extends a line of coral reefs for a distance of sixty miles, enclosing a lagoon a mile in width, within which are thousands of coral clumps, or shoals, each one a marvelous sea garden in itself. It is planned to select one of these clumps as a basis for a new group, and to depict the characteristic variety of corals, sea fans, sea plumes and reef fishes of brilliant colors. In this connection it is planned to cooperate with Mr. J. E. Williamson, the inventor of the undersea tube which is now at Nassau in the Providence Islands. During his trip, Dr. Miner descended in this tube and looked out upon the submarine world through a plate glass window one and a half inches thick. The use of the tube will facilitate an accurate and authoritative study of undersea life to a degree not otherwise possible. Diving apparatus will be used for collecting the specimens yet necessary for the group. Arrangements are being made with the Bahama Government through the courtesy of Sir Harry Cordeaux, governor of the islands, to conduct the work under his official sanction. An expedition comprising several artists and other technical experts of the museum staff will leave shortly, under Dr. Miner's leadership, to engage in this undertaking. It is expected that three years will be required to complete the group.

AN invitation was recently extended by the Rockefeller Foundation to Japanese scientific men who were deprived by the earthquake of all facilities for work to go to Peking to continue their investigations in the laboratories of the Peking Union Medical College. Eight men from the Imperial University and the Imperial Institute for Infectious Diseases were appointed by the authorities of the university in Tokyo, and they have now begun their work in the laboratories of pharmacology, physiologic chemistry and bacteriology. The party is headed by Dr. Nukada, professor of pharmacology of the Imperial University of Tokyo. Among the units of the Imperial University that were completely destroyed were the buildings which housed the departments of physiology, pharmacology and biochemistry.

DURING the past summer, as we have already reported, a project for the investigation of hookworm disease in China was initiated under the joint auspices of the department of pathology of the Peking Union Medical College and the International Health Board of the Rockefeller Foundation. Dr. W. W. Cort and Dr. J. B. Grant are cooperating in the direction of this work. Dr. Cort has been carrying on similar investigations in the West Indies for the last three years. The *Journal* of the American Medical Association further states that Dr. N. R. Stoll, who was recently appointed associate in parasitology on the staff of the Peking Union Medical College and who took part in the West Indian expedition, will devote his entire time to the work. In addition, two Chinese physicians and several technicians have been employed. A field laboratory has been established at Soochow Hospital, where both laboratory and field work were started on July 1. Early in August, Dr. Cort and Dr. Grant proceeded to Chefoo, where a survey was made with headquarters at the Temple Hill Hospital. Later in the year, work will be undertaken at Canton in cooperation with the Canton Christian College. It is planned to carry on this work in China until October, 1924.

ANNOUNCEMENT is made by the Dominion Government that the Federal Fisheries Department is about to establish a new biological station at Prince Rupert, B. C. It will be utilized for research work in connection with the fisheries of the coast, and also for the dissemination of information of educational value.

The British Medical Journal writes: "The munificent gift made by the Rockefeller Foundation to University College, London, and its Medical School, will not have been forgotten. It has been, however, long understood that the foundation did not intend to limit to London the financial assistance it would give to medical educational institutions in Great Britain. We understand that the foundation has for some time been making inquiries in Edinburgh, and is about to provide the cost of a clinical research laboratory there; it is also considering the endowment of a chair in clinical surgery."

THE twenty-fourth biennial edition of the directory of the Washington Academy of Sciences has been issued. This contains the names and addresses of members of the academy and of each of the sixteen affiliated societies. A list of the scientific and technical societies of Washington which are not affiliated with the academy, and of national societies having headquarters or offices in Washington, is also included.

BY the provisions of the will of the late Dr. William Johnson Walker two prizes are annually offered by the Boston Society of Natural History for the memoirs written in the English language. For the best memoir presented a prize of sixty to one hundred dollars may be awarded; for the next best memoir a prize not exceeding fifty. The subject for 1924 is any work in the field of botany, for 1925, any work in the field of geology or mineralogy.

UNIVERSITY AND EDUCATIONAL NOTES

THE College of Forestry of Syracuse University has received as a gift from Charles Lathrop Pack, of Lakewood, N. J., a tract of 1,000 acres of Adirondack forest land at Barber Point, Cranberry Lake. It will be known as the Charles Lathrop Pack Demonstration Forest.

ACCORDING to an announcement from Carnegie Institute of Technology in Pittsburgh, a fellowship in metallurgy of the value of $750 has been established by the department of metallurgical and mining engineering, for which an appointment is to be made immediately. The first problem to be studied under the fellowship is "an investigation of the effects of small percentages of phosphorus on the physical properties of low carbon steel especially under alternating stresses and shock."

LADY RODDICK has given $50,000 for the erection of an entrance to the grounds of McGill University in memory of her husband, the late Sir Thomas Roddick.

DR. ORLANDO H. PETTY, physician in charge of the Department of Metabolism of the Philadelphia General Hospital, has been appointed professor of the diseases of metabolism in the graduate school of medicine of the University of Pennsylvania.

DR. DAVID P. BARR, assistant professor of medicine at the Cornell University Medical College, has been appointed Busch professor of medicine by Washington University, St. Louis.

DR. H. C. HOWARD, formerly research chemist on the staff of the B. F. Goodrich Co., is now assistant professor of chemistry at the University of Missouri.

DR. FAY-COOPER COLE, assistant professor of anthropology in Northwestern University and curator in the Field Museum of Natural History, has been appointed to give instruction in the department of sociology and anthropology at the University of Chicago.

DISCUSSION AND CORRESPONDENCE

UNIFORMITY IN WEIGHTS AND MEASURES

To close the discussion, may I say that Mr. Russell's statement in SCIENCE, November 30, 1923, pp. 442–3, needs careful reading. He says:

> The Troy pound (which is Mr. McAdie's another kind of pound) was abolished as a legal weight in the United Kingdom eighty years ago and the Troy pound is likewise entirely obsolete in the United States. There is accordingly only one pound weight in the United States and United Kingdom.

This conveys the impression (while not explicitly saying so) that the Troy pound *has been legally abolished* in the United States and is entirely obsolete.

On the contrary the only authorized material standard of weight in this country is the Troy pound at the Mint (if we except Kilogram No. 20, delivered at the White House January 2, 1890). Moreover if one asks for a pound of gold at the Mint (we have no present intention of doing so) he will get 12 ounces, 5,760 grains. But the farmer who sells a pound of golden butter must give 16 ounces, 7,000 grains, or go to jail. Some day some farmer Senator will discover this and use it as campaign ammunition.

Mr. Russell says "the long ton is obsolescent." Uncle Sam then must be sound asleep, for the United States Government requires in fuel deliveries 2,240

lbs. to the ton. Most large corporations do likewise. Personally we are entirely willing to pay for a hundredweight of coal and receive 112 pounds, that is, eight stones (a stone as we all *readily* remember being 14 pounds). But we only get an uncertain number of stones in each ton; and the ton remains 2,000 pounds. We are thankful that there is not a Troy ton, or we might get that (1,500 lbs.).

Mr. Russell argues that the old English weights and measures are uniform and consistent. He therefore proposes a new ounce to weigh 436.947 grains. We now have two ounces, one of 437.5 grains and another of 480. Who then could tell how many grains there were in a pound, a hundredweight or a ton? Why not let the grain depart in peace? No one now uses it, whereas the gram is in general use among scientific men and is entirely satisfactory.

ALEXANDER MCADIE

AN ILLUMINATING METHOD OF HANDLING DATA

THERE has come to my observation a notable method of treating data, one worthy the attention of the curious in such matters, and casting light upon certain other things of interest. A circular letter entitled "Biologists under cross-examination on the inheritance of acquired characters," to which is attached the name of Casper L. Redfield, has recently been distributed. Appended to it are what purport to be "parts of letters received" from certain biologists in answer to inquiries from various persons concerning the inheritance of the effects of the organism's responses to its environment (as distinguished from the direct action of the environment). With regard to these letters it is stated that "in the cases in which the question was directly answered, that answer was usually confined to one or two sentences in a letter filled with irrelevant matter," and as to the replies quoted it is said that "the replies given are simply those parts of the letters received which answer the questions asked—irrelevant matter being omitted." Among these replies the following (in answer to an inquiry from a Mr. Herdman) is given as my contribution:

Dear Mr. Herdman: I have little or nothing that will help you. Redfield's work has been criticised as unsound. Otherwise, nothing has been published.

H. S. JENNINGS.

The pertinent points regarding this are as follows:

(1) My letters to Mr. Herdman contain no such passage or passages. Not one of the sentences quoted is found in my letters to Mr. Herdman or to any one else.

(2) Except for the trend of the comment on Mr. Redfield's work the passage does not give even remotely the sense of what I wrote. In addition to Mr. Redfield's writings I referred the inquirer to Kammerer's extensive work, which is almost entirely on the heritability of the organism's responses to the environment; to Semon's book, "Das Problem der Vererbung Erworbener Eigenschaften," which contains accounts of many investigations along this line; to the recent work of Griffith and Detlefsen on the inheritance of the reactions produced in rats by whirling, and to other works. I did not say, "I have little or nothing that will help you," for I hoped that these references would help him. And I obviously did not say that other than Redfield's work "nothing has been published," since I gave references to other things that had been published. I am driven to conclude that these two sentences are metamorphoses of the following. After the somewhat extended letter, with references to the literature, above mentioned, a brief second letter to Mr. Herdman (in answer to an inquiry as to the nature of the criticisms on Redfield) said: "I felt that I had little or nothing to add that would help you, so that I have not hurried about replying." (Note the words "to add," the omission of which from the ostensible quotation completely changes the sense). After referring him to Pearl's review of Redfield, my summary of the situation concluded by saying that "a great many persons have worked along lines similar to this, but in most cases the results have been negative, so that nothing has been published on the work or the work has attracted no attention, since there were no definite results." Nothing else in my letters bears the least resemblance in either words or meaning to the first and third sentences in what purport to be "parts of the letters received" from me.

The student of scientific method will find it an enlightening exercise to analyze in detail the methods employed in the author's treatment of the raw data given above, in order to get out of them his finished product; to formulate the general principles under which these operations are carried out; and to meditate upon the wonderful potentialities opened up by the application of these methods and principles to the data of genetics. Upon the reader that will carry out this analysis a great light will dawn as to how it happens that the author claims that the matters discussed in his published works demonstrate the inheritance of acquired characters; and as to the weight to be given to those claims.

H. S. JENNINGS

JOHNS HOPKINS UNIVERSITY

SOME IMMIGRANT CLOVERS

IN April, 1923, my attention was called by Protessor Paul Tabor, of the Georgia Agricultural College, Athens, Georgia, to a clover said to be growing in

northeastern Georgia and to be new to that section. It had been first observed by Mr. D. J. Pitts, of Bowman, Georgia, and material was later sent me by Mr. Pitts, who also wrote as follows:

I first noticed this clover some five or six years ago in my crimson clover and thought nothing of it at that time, but it stayed on this piece of land without any help, and volunteered each year until it covered a place ten by twenty feet; so I stripped a few seed last spring and sowed them in a field on a strip ten by seventy-five feet; it, also, grew well.

This clover proved to be *Trifolium striatum* L., a species widely distributed in Europe. It seems to be quite at home in northern Georgia since the plants sent by Mr. Pitts were all more than 4 dm in height, one plant with thirty stems from the crown growing to a height of more than 6 dm. Seed ripens about the last of April or early May. This species may become of economic importance.[1]

The species listed below were all sent in by Professor Paul Tabor, of Athens, and Mr. W. J. Davis, of Tifton, Georgia, who with Mr. H. C. Appleton, of Athens, Georgia, collected the plants at Snow Hill, Alabama. Concerning these species nothing is known as regards the length of time they have been in this country nor how widely spread they may be. Professor Paul Tabor wrote under date of May 23, 1923, as follows:

All of these clovers were picked up (on May 13) during an hour's stroll up the railroad from Snow Hill, Alabama. The railroad track has ballast of lime rock. All of these clovers were found growing within a few inches of this ballast but had apparently not scattered to the sides of the embankment or the cuts.

The writer hopes to be able to study these clovers next spring, but meanwhile it seems best to place on record the fact that these European clovers, mostly Mediterranean, have been found growing wild in the United States. Dr. Chas. Mohr in "Plant Life of Alabama," 1901, p. 562, says regarding *T. resupinatum*, "Adventive with ballast. Mobile, June, 1887; not observed of late years." A complete set of specimens has been deposited with the United States National Herbarium and, so far as material was available, with the Gray Herbarium and the Herbarium of the New York Botanical Garden.

Species of *Trifolium* collected at Snow Hill, Alabama, May 13, 1923:

T. glomeratum L. — *T. resupinatum* L.
T. lappaceum L. — *T. scabrum* L.
T. nigrescens Viv. — *T. suffocatum* L.
T. tomentosum L.

A. J. PIETERS

In Charge of Clover Investigations, U. S. Dept. Agriculture

[1] Since writing the above Doctor B. L. Robinson has kindly furnished the following record of specimens of *T. striatum* in the Gray Herbarium and in that of the New England Botanical Club.

"Ballast, Camden, N. J., I. C. Martindale, 1880."

"In old field, Eastham, Mass., June 22, 1914, F. S. Collins, No. 2309."

"Forming prostrate rosettes, dry sandy field and borders of woods, Harwich, Barnstable Co., Mass., June 25, 1918, M. L. Fernald, No. 16,960."

"The Collins specimen is in the herbarium of the New England Botanical Club; the others in the Gray Herbarium."

QUOTATIONS

THE ENDOWMENT OF RESEARCH

THE new policy of the Royal Society may fairly be called the endowment of maturity; there is no reason to quarrel with it on that account. The society exists, as William, Viscount Brouncker, its first president, said in accepting the charter granted by Charles II, "for improving natural knowledge," and no body more competent to decide how funds can best be applied to this end could be found than the council of the Royal Society, upon which experts in all departments of science sit.

The policy was stated and explained by the president in the anniversary address. The society has been able for a good many years past to make certain annual payments from sums which it receives, chiefly from the Donation Fund and the Government grant. These have been used mainly to assist workers of promise in the early period of their career by providing the cost of apparatus and material, through research studentships, and by the Sorby Fellowship. In recent years the society has come into the enjoyment of certain bequests and gifts—the Foulerton gift and bequest, yielding £5,050 a year, the Messel Fund, yielding £1,575, and the Yarrow Fund, £5,450. Still more recently the death of Dr. Ludwig Mond's widow has liberated his bequest, which, it is anticipated, will yield an annual income of about £2,500. These new sources of income have placed upon the society the responsibility of determining the best way of expending them. The policy it has now adopted is interesting from several points of view. It has decided that the income may best be spent in creating greater opportunities for experienced investigators of already proved first-rate capacity in research. Such men as a rule have hitherto occupied positions in universities or other institutions which require from them manifold duties. In almost all such institutions they must give up much of their time to teaching, and there are many other calls upon them of an administrative kind, and such calls are likely to increase

rather than diminish. Thus they are taken away from research, the field of work in which their capacity has been proved. The society has deliberately inverted the order of precedence of professorial functions; it has placed its new professors in a position to regard research as their primary duty, and thereby has sought to recognize research as a definite profession, and to advance and to maintain the principle that the laborer is worthy of his hire no less when engaged in research than when he is employed in class instruction.

The need for a definite systematized policy was made the more urgent by the munificent gift of Sir Alfred Yarrow to the society early this year. In his letter of last February announcing his gift Sir Alfred Yarrow said that he would prefer that the money should "be used to aid scientific workers by adequate payment, and by the supply of apparatus or other facilities, rather than to erect costly buildings, because large sums of money are sometimes spent on buildings without adequate endowment, and the investigators are embarrassed by financial anxieties." In arriving at its new policy the council of the society has been advised by a committee of which the donor is a member, so that there can be no doubt that it commends itself to him.

The first indication of the new policy was afforded just a year ago when Dr. E. H. Starling was appointed Foulerton Professor. Down to that time he had held the Jodrell chair of physiology in University College, London, and in that capacity his primary duty was to teach undergraduate students. The series of brilliant researches by which he has laid physiology and medicine under so heavy a debt were, strictly speaking, secondary. At the same time let us recognize that he could not have been so good a teacher of physiology had he not himself been, through all the years of his teaching, an active research worker. He is continuing to work in the Physiological Institute at University College, which was brought into existence mainly through his exertions, and will remain a permanent memorial of the trust his character and achievements have inspired. The two Yarrow professors—the one, Professor Fowler, of the Royal College of Science, South Kensington, distinguished for his research in spectroscopy and astrophysics, and the other, Mr. G. I. Taylor, of Cambridge, whose contributions to the mathematical theory of hydrodynamics and to the physics of crystals are recognized to be of the greatest originality and importance—will both, like Professor Starling, continue their researches in the laboratories of whose traditions, as the president said, their reputations are already a part.

The policy the Royal Society has adopted to guide it in the administration of the funds that have recently come under its control may therefore be regarded as presenting two closely related but slightly different aspects. In the first place it recognizes that certain professors should be relieved from the duty of teaching in order to devote themselves entirely to researches in which they have already gained distinction; in the second place it establishes the principle that a man of suitable temperament and abilities should be able to look upon pure research as a definite calling or profession in itself, which holds out to him a prospect that in the full maturity of his powers he may be placed in a position to give all his energies to following up the line of scientific inquiry in which he has already achieved success. It is a serious adaptation of Disraeli's rather cynical epigram that nothing succeeds like success.—*The British Medical Journal.*

SPECIAL ARTICLES

THE BEHAVIOR OF THE GERMINAL EPITHELIUM IN TESTIS GRAFTS AND IN EXPERIMENTAL CRYPTORCHID TESTES (RAT AND GUINEA PIG)[1]

THE writer and others have shown that rat and guinea pig testes can be transplanted into other rats and guinea pigs and persist for long periods of time. It is generally admitted by all workers who have observed histological preparations of mammalian testis grafts that the germinal epithelium, the lining of the seminiferous tubules, is without exception degenerate or entirely absent. I pointed out in 1921[2] that all testis grafts do not react in the same way, as indicated by the histological picture; thus (pages 379–382), of two guinea pig testis grafts recovered from spayed females seven and nine months after operation, one consisted of seminiferous tubules entirely devoid of an epithelium aside from a few scattered cells along the basement layer of the tubule, whereas the second one possessed tubules in active mitosis and an epithelium of two to three cells in thickness.

Since the publication of the above results approximately one hundred testis grafts have been recovered from operated rats one to seven months after transplantation. Histological preparations reveal a wide diversity of reactions of tissues following transplantation; differences in the condition of the germinal epithelium as well as of the interstitial cells are very marked. These grafts represent subcutaneous, intramuscular and intraperitoneal transplantations and have been recovered from castrated males, spayed

[1] This investigation has been aided by a grant from the Committee on Sex Research of the National Research Council; grant administered by F. R. Lillie.

[2] *Jour. Exp. Zool.*, Vol. 33.

females, normal males, normal females and females which while possessing the testis graft had become pregnant, delivered and suckled a normal litter of young. So far as a study of these has progressed it is impossible to make a general statement concerning any differential behavior that is correlated with a particular type of animal. It is sufficient to state, at this time, that active cell division may go on in the tubules of grafts in either normal males or in normal females; an epithelium of several cells in thickness, containing many cells undergoing mitosis, is not a rare condition to find. The interesting fact, for the moment, is that grafts taken from the localities mentioned, despite their active mitotic condition, have never contained spermatozoa in the tubules; many cells, apparently spermatocytes, are often found free in the lumen of the tubules, having been loosened from the central border of the epithelium. Some influence is at work that prevents the building up of a completed epithelium with differentiated spermatozoa; instead, the cells near the stage of differentiation either degenerate in place or are cast off into the lumen of the tubules, where apparently they degenerate and are absorbed. No one, to my knowledge, has ever found spermatozoa differentiated from the germinal epithelium of a mammalian testis graft. In birds apparently the smallest nodule of testicular material, grafted or accidentally remaining attached to the peritoneum following castration, may contain an abundance of spermatozoa. Some light is thrown on this condition in mammals by a study of experimental cryptorchidism, a brief discussion of which follows.

Before passing on, it appears desirable to mention again the possibilities of an antagonism existing between the sex glands of the male and the female. Steinach[3] has postulated the sex antagonism idea largely, perhaps, to account for his inability to obtain persistence of testis grafts in females, or ovarian grafts in males, without first having removed the glands of the animal into which the transplantations were made. By transplanting an ovary and a testis at the same time into a previously castrated animal he was able to obtain persistence of each, and considered that the antagonism had been partially broken down by this procedure. Knud Sand, however, was able to obtain persistence of an ovary grafted *into the substance of a normal testis in the male.* Yet he, too, was apparently unable to obtain growth of a subcutaneous graft in an animal of the opposite sex than the graft, without first removing the glands of the host animal. These findings were responsible for his disagreement with Steinach on the question of the *antagonistic action* of the two different sex glands, and to the formulation of his *atreptical immunity* hypothesis. This hypothesis, in brief, supposes that the body produces a specific substance for the nutrition of the sex glands, and that these glands tend to extract this specific nutritive substance from the general circulation and to store the same within its own substance. Thus, should an ovary be grafted subcutaneously into a normal male, the testes would have utilized all this specific substance and none would be available for the graft: hence it would perish. However, should an ovary be placed within the testicle, this specific food principle would be localized at that point and could be utilized by the ovarian graft as well as by the testis itself; thus explaining why subcutaneous grafts do not persist, whereas grafts within the normal gland of the animal are retained.

I have been unable to find justification for either the *antagonism* or *atreptical immunity* hypotheses; no difficulty has been encountered in obtaining grafts one to ten months after transplantation of either testis in females with both ovaries present, or ovarian grafts in males with the two testes present and normal. When the experiments were first begun it was often convenient to operate two animals at the same time, removing one ovary from a female to graft into the male, and a testis from the male to graft into the female. Since in the majority of my reported cases such a procedure had been employed, a certain French reviewer was led to believe that my experiments substantiated Sand's contentions;[4] he has taken for granted the *necessity of the removal of one gland* of the host before the graft (of opposite sex) will grow. Inasmuch as he considers it possible that one gland of the host animal is unable to remove all the specific nutritive substance from the circulation it would follow that the implanted one could obtain sufficient materials for growth and would thus persist.

I wish to emphasize unmistakably that these assumptions are entirely unwarranted. I have recovered many testicular grafts after three to seven months' existence in unbred normal females and in females both of whose ovaries have remained intact and in which pregnancy has occurred, with delivery and the normal suckling period following in the usual manner; yet in such cases the germinal epithelium of the testis graft may be in an active mitotic condition. A student, Mr. N. F. Fisher, has repeated the work of grafting ovaries into males both of whose testes were undisturbed; such ovary grafts, recovered months after the original operation, consisted of typical ovarian tissue in which there were great numbers of active Graafian follicles with normal ovocytes.[5]

In view of the results reported above there should

[3] For a discussion of this question see Moore, *Jour. Exp. Zool.,* Vol. 33, 1921, pages 129–173 and 365–390.

[4] See *Revue Scientifique,* No. 6, 1921 (Bohn).

[5] See Fisher, *Amer. Jour. Physiol.,* Vol. 64, 1923.

no longer be any question of the persistence of a sex gland graft in an animal of the opposite sex with its normal gonads intact. Such assumptions as are implied in the *antagonism and in the atreptical immunity hypotheses* are entirely superfluous and unwarranted so far as my material is concerned.

EXPERIMENTAL CRYPTORCHIDISM

The varying histological reactions of testis grafts had proven so puzzling a study that it was highly desirable to study the progressive degeneration of a testis and the interstitial cell hypertrophy on controlled material. Ligation or resection of the vas deferens (or both) have been reported to produce such a condition as is desired, and should furnish such graded steps as are necessary. With this in mind Mr. Robert Oslund began such a study at my suggestion somewhat over two years ago. Curiously enough, however, the expected results did not follow; indeed, quite the reverse. Degeneration does not necessarily follow such operative procedures.[6] A second possibility of graded degeneration changes of the testis is based upon a study of cryptorchidism. Since undescended testes of mammals (human, pig, sheep, horse, etc.) are devoid of germinal epithelium, apparently without exception, and contain an excessive amount of interstitial cells, it was thought possible to produce such conditions by operative means.

The guinea pig and rat are among that group of mammals in which the inguinal canal is open and the testis easily retracted into the abdomen. It is a simple matter to free the testis from its slight attachment to the bottom of the scrotal sac and the vas deferens from its mesentery. Thus the testis may be returned to the peritoneal cavity to remain therein with all its blood vessels, the vas deferens and nerve supply intact. Preliminary experiments on the guinea pig showed that a testis free, or held fast by sutures, within the peritoneal cavity for sixty days (with or without closure of the inguinal canals) had completely lost its germinal epithelium and possessed an enormous interstitial cell complex.[7]

Further experiments brought to light the fact that a guinea pig testis retained uninterruptedly in the peritoneal cavity for seven days will show considerable degeneration changes; the epithelium of the tubules is usually highly disorganized and cells have been loosened from it. Spermatozoa are rarely present. By fourteen days the degeneration has progressed considerably: by twenty days usually none of the germinal epithelium remains, excepting possibly a single layer of cells at the periphery of the tubule. Beyond this length of time of retention, the interstitial cell mass becomes the outstanding feature of the preparations.

In the process of this degeneration cells appear to become gradually loosened from the epithelium and to escape into the lumen of the tubules; other cells of the epithelium lose all signs of cell boundaries and coalesce into discrete, multinucleate masses of protoplasm. Such "Giant cell like" masses may be loosened from the epithelial layer and be found in the open lumen, or they may undergo further degeneration in the epithelial layer.[8] Such degeneration follows if the testis is free or fastened in the abdomen; whether the inguinal canals remain open or closed; and when the scrotal sac is completely everted and fastened to the peritoneum within the cavity, the attachment of the testis to the scrotum remaining normal.

Many times the testis, having been placed in the peritoneal cavity without closing the inguinal canals, will return to the scrotum completely or partially. Such a testis may be normal, partially or completely degenerate (as concerns the epithelium), depending upon the length of time it has remained in the abdomen before its return. Should adhesion result in retention of the testis in the upper part of the inguinal canal many normal tubules as well as degenerate ones are found.

Considerable recovery of the epithelium is possible after return to the scrotum. Thus, both testes of a normal guinea pig were confined within the peritoneal cavity for twenty days; by a second operation one was removed as a control for the amount of degeneration, whereas the second was returned to the scrotum and fastened by sutures. The epithelium of the testis removed at twenty days consisted of but a single layer of cells in the tubules in the midst of a fibrillar reticulum. The second testis was removed three months after returning it to the scrotum and it was found to have recovered to such an extent that many of the tubules were normal and contained spermatozoa; the majority of the tubules had not so completely recovered.

Thus it is seen (for the rat and guinea pig) that a normal germinal epithelium is dependent upon nor-

[6] See Oslund, *Proc. Amer. Soc. Anat.*, 1923; *Anat. Rec.*, Vol. 25, page 145.

[7] Before completion of my own experiments a paper appeared by Knud Sand (*Jour. de Physiologie*, '21, Vol. 19, p. 515), reviewing his earlier work on this subject, published in his Danish Monograph 1918. My own work confirms and extends the work done by Sand. Other earlier work will be reviewed at a later date.

[8] It should be stated that the effects on rat testes are less extreme than on the guinea pig testis. Often after two months in the peritoneal cavity a rat testis may possess two or more layers of cells in the epithelium, but no spermatozoa are present.

mal relations of the testis to the scrotum; a scrotal testis is normal, an extra-scrotal testis degenerate. Here, then, is a partial answer to the question of why an active epithelium in an intramuscular, subcutaneous or intraperitoneal rat testis graft never possesses spermatozoa. Furthermore, if such a relationship between a normal germinal epithelium and the scrotum holds, it would be expected that a testis grafted onto the walls of the scrotum would develop a normal epithelium.

RAT TESTIS GRAFTS IN THE SCROTUM

In making grafts of testis onto the walls of the scrotal sac one must employ relatively small amounts of tissues in order to permit of vascularization, and preferably testis tissue before the establishment of the germinal epithelium. Testes were taken from just born rats (two to ten days old) and the entire testis grafted onto the walls of the scrotal sac of a sixty-day-old castrated male. Such grafts recovered from the scrotum six months after the transplantation have been found to contain some tubules that were entirely normal and possessing spermatozoa. Most of the tubules were degenerate; many contained an actively proliferating epithelium. To my knowledge this is the only case on record where spermatozoa have been differentiated from a mammalian testis graft.

It is not surprising that all tubules do not contain spermatozoa. Interruption of blood supply is quickly fatal to the germinal epithelium and it must be remembered that the normal testis is vascularized by the internal spermatic as well as by the artery of the vas deferens. The graft is deprived of both these arterial supplies and must depend for its blood supply upon the small vessels of the scrotal sac wall. The limitations of a graft in such a position as this depends upon the amount of blood supply that can be brought to it.

These results confirm our supposition that a normal germinal epithelium and the differentiation of spermatozoa are dependent upon some influence derived from the position of the testis in the scrotum. The factors involved are not fully known but I am inclined to the suggestion of Crew[9] that body temperature may be the responsible agent. The scrotum may act as a local regulator of the temperature of these parts. Details of this work will be presented more fully at a later date.

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[9] F. A. E. Crew, *Jour. Anat.* (Lond.), Vol. 56, p. 98, suggests on hypothetical grounds that the aspermatic condition of imperfectly descended testes may depend upon a temperature gradient locally controlled by the scrotum.

ADDENDUM

Since the above account was written experiments, designed to test the hypothesis that germinal epithelium degeneration in undescended and artificial cryptorchid testes is due to a different temperature relationship established and probably locally controlled by the scrotal sac, have been brought to a close. The writer, in cooperation with Mr. Robert Oslund, using the sheep as the experimental animal attempted to insulate the scrotum from loss of heat by secure wrappings. After a period of eighty days the testes were found to be entirely devoid of spermatozoa. The majority of the seminiferous tubules were decidedly degenerate and presented similar conditions to many of the artificial cryptorchid testes; control testes were in full gametogenic activity.

N. Fukui has shown that local application of heat to the scrotum produces germinal epithelium destruction and the writer has been able to confirm these findings. It thus appears very probable that increased temperature is the operating factor in the degeneration of the epithelium, but it is well recognized that this may not be the only factor.

THE AMERICAN CHEMICAL SOCIETY

SECTION OF CHEMICAL EDUCATION

Edgar F. Smith, *chairman*
Neil E. Gordon, *secretary*

How shall we feed our children? MARIE DYE. The problem of correct food for children may be roughly considered in two parts: first the quantitative, dealing with the amount of food required and second the qualitative, showing the kinds of food. Research in calorimetry has given the basis for the former and enables us to calculate the amount of food required by children of various ages. The qualitative aspect of the food problem necessitates the study of food composition and the research with animals. Fats and carbohydrates are useful chiefly as fuel foods, while proteins, certain inorganic elements and vitamines are needed for growth and maintenance. The amount of protein, calcium, phosphorus, etc., required is determined through balance experiments. It is then a simple matter, when the chemical composition of food is known, to select the kind and quantity to fit the needs of the child. The animal work on vitamines has shown their importance, and our experiments during the war proved that this information may be applied to children. Thus the knowledge of the chemical composition of food and the quantitative needs of the individual give a reliable basis for the selection of food for children.

Some problems in chemical education which are vital to the development of the chemistry in this country: NEIL E. GORDON. Reasons are given for the importance of the twelve following problems in chemical education in the development of the chemistry of this country: (1) Chemical training in the high school; (2) correlation of high school and college chemistry; (3) chemical train-

ing in college; (4) methods and devices used in the presentation of chemistry; (5) correlation problems; (6) standardization problems; (7) chemical education of the layman; (8) chemical education of the industrial man; (9) educating the chemist in the industry; (10) chemical education as a profession; (11) a national organization of chemical education; (12) a journal on chemical education.

Chemical education via radio: D. H. KILLEFFER. This paper deals with the broadcasting of popular talks on the subject of chemistry via the radio telephone. The discussion is based on the writer's experience in broadcasting ten talks on a variety of chemical topics from the Westinghouse station in New York. The method of arranging for the series is described, the subject-matter treated and the points to be borne in mind by those who prepare such talks are mentioned. Three points in delivering a talk to a radiophone are brought out: First, the subject must be interesting and must be interestingly treated, for radio audiences "walk out" easily and quickly if their interest is not sustained; second, each talk of a series must be complete in itself on account of the fact that the audience is extremely impatient with things it does not understand and it is very easy for one or more talks of a series to be missed; and third, the delivery of the speaker should be clear, deliberate and without raising the voice above the ordinary tone.

Chemistry and civilization: D. L. RANDALL. This is designed to be a popular illustrated lecture in which the writer undertakes to show to what extent the development of civilization has depended on the work of the chemist. He has made possible the development of great cities and modern methods of industry by preparing iron and steel in abundance. The work of the metallographer is pointed out. The development of the electrical industry has been materially assisted by the discovery of the chemical battery and the electrolytic refining of copper. The cement industry is a chemical industry. The manifold uses to which sulfur and salt are put are given, also the products obtained from coal and coal tar. The hand of the chemist is seen in the production of fertilizers, the preparation of new foods, the study of nutrition, the preparation of medicines and the purification of water. Finally, the chemist has improved the quality of merchandise by his methods of testing, has had a share in introducing the laboratory method into educational work and has used his efforts to have the public attack all problems in a scientific manner.

The training of chemistry teachers: B. S. HOPKINS. A good teacher is the most important factor in any chemical course of study. Many superior teachers are succeeding wonderfully well in spite of dingy laboratories, meagre equipment, mediocre textbooks or inadequate libraries. There is a heavy annual demand for teachers of chemistry who know both method and subject-matter. Graduates of colleges or universities may know chemistry, but as a rule they have had no training in teaching the subject; graduates of normal schools are well trained in methods of teaching, but all too frequently they do not know chemistry. The American Chemical Society has appointed a committee to consider methods for improving the teaching of chemistry in the high schools of the country. Even if it were possible for this committee to present a perfect outline for a course in chemistry, little improvement can be expected unless the higher institutions of learning are willing to take up the task of supplying well-trained teachers of chemistry.

Making high school chemistry worth while: C. E. OSBORNE. The reconstruction period following the world war has had its influence on educational work. Curriculum reconstruction is much discussed. To retain its place in the high school course, chemistry must show itself worthy. The subject "Making High School Chemistry Worth While" is, therefore, timely. Any achievement, mental or material, involves certain factors. Art demands an artist, a vision, a plan, paints and brushes and canvas; the picture is the vision become a reality. To make high school chemistry worth while demands a teacher, a definite purpose, a plan of work, materials with which to work, and material to be fashioned—the boy or girl in the sensitive, impressional formative period. The ultimate product should approach the highest type of American manhood and womanhood. This paper will briefly discuss each of the above factors.

Qualitative analysis without hydrogen sulfide: R. D. MULLINIX. G. Almkvist has proposed a method without the use of H_2S, but uses Na_2S followed by H_2SO_4. (*Zeit. anor. Chem.*, 103, 221–242 (1918)). A number of similar methods have been proposed. I have used for the past two years a method in which, after the removal of the silver group by HCl, a mixture of NaOH, Na_2CO_3 and bromine water precipitates a group of hydroxides and carbonates, which are then further separated by HNO_3 followed by NH_4OH, $(NH_4)_2CO_3$, etc. The As, Sb, Sn, Pb trace, Zn, Al and Cr are in the filtrate. This is divided by HCl followed by NH_4OH and zinc tested for in the presence of chromate and arsenate by the potassium ferrocyanide method worked out last year. The method will detect "traces" with as much certainty as will the sulfide method. Organic matter, phosphates, etc., can be handled. There are certain advantages in the use of the method, among these being: (1) The usual trouble with colloidal suspension, especially sulfur, is avoided; (2) the analysis can be performed without the use of the hood. Work is being done at the present time to determine the minimum concentration of each ion that can be detected.

A method for determining the formula for carbon dioxide (an experiment for elementary students): W. L. EVANS, J. B. PETERSON, H. B. HASS and G. P. HOFF. This experiment consists of two parts: (a) Determining the quantitative composition of carbon dioxide by passing oxygen over a weighed amount of dry activated charcoal contained in a porcelain boat. The boat is placed in a small combustion tube and is carefully heated while oxygen is being passed over its contents. The carbon dioxide, thus formed, is collected in a small U tube filled with soda lime and previously weighed; (b) the weight of one liter of carbon dioxide is determined by passing a known volume of the gas (made in the usual laboratory manner) into a soda lime tube as described above.

A method for determining the weight of one liter of steam (an experiment for elementary students): W. L. EVANS, C. S. PEASE and C. D. BLAND. This experiment consists of two parts: (a) Filling a liter flask, previously heated to 106°–110°, with steam; (b) passing the steam thus contained into a calcium chloride tube previously weighed. A current of dry air is used to sweep the steam from the liter flask. All these steps should be carried out while the flask is immersed in a calcium chloride bath contained in an ordinary galvanized iron bucket.

Some helps in elementary qualitative analysis: JESSE E. DAY. The following laboratory helps were used in the course in general chemistry for engineering students at the University of Wisconsin: (1) Copious and gelatinous precipitates were filtered by suction; the suction apparatus was constructed from two 250 cc wide mouth bottles and an ordinary funnel; (2) blue-prints showing the wash-flask, H_2S precipitation flask and suction outfit, with detailed angles and dimensions, were hung in the laboratory; the result was more uniform and presentable apparatus; (3) each student was supplied with a set of mimeographed skeleton equations covering the metals and arranged with reference to the reagents; the student was required to regroup these according to the metals and also complete them; (4) the sodium thiosulfate method for the separation of copper and cadmium was used with excellent success; (5) a modified automatically closing individual hydrogen sulfide cut-off has been developed at the University of Wisconsin; (6) a modified general chemistry record card has been designed.

Some illustrations of molecular and atomic magnitudes for undergraduate classes: JAMES KENDALL.

A neglected professorial duty: PAUL M. GIESY. Chemistry teachers should remember that chemistry is usually a means of livelihood as well as a science. Students contemplating chemistry as a profession are entitled to complete information as to probable remuneration, working conditions, opportunities for advancement and other economic considerations. Few students realize that research on a subject of their own choice is a luxury attainable only by those who have independent incomes, or who are willing to give up the prospects of a family, at least for many years. The present tendency for heads of university laboratories to require younger members of their staffs to work on problems in which the heads are interested further restricts the chance to work on one's own problems.

Chemical spelling: C. A. JACOBSON. Chemical spelling has attracted considerable attention since first reported about a year ago. The second annual contest at the West Virginia University was held last May, and the results of the two contests held would doubtless warrant a brief report at the A. C. S. meeting in Milwaukee. The method of conducting the contest and of selecting the contestants from the preliminary matches have been improved upon. The winner in the final contest is now chosen on a percentage basis. Different means of arousing interest in the contest have been tried. At least one other university has tried chemical spelling with good results. The subject has been discussed in SCIENCE and the news edition of the *Jour. Ind. and Eng. Chem.*

The response of high school pupils to chemical education: HERBERT R. SMITH. Chemical knowledge has contributed enormously to human progress. It can contribute much more when the population as a whole has a better understanding of things chemical. The logical time for such education is in youth, while the pupil is most impressionable and has his lifetime yet ahead. But chemistry as well as other subjects will not attract modern pupils if taught by antique methods. The subjects of the high school must compete with the modern world of amusements for the pupil's time. Chemistry can compete successfully only when it is *taught in terms of its service to mankind.* But not many high school teachers are doing this now. They lack knowledge and contact with the service side of chemistry. Interest and enthusiasm for chemistry can not grow only in the atmosphere of academic teaching. They must take root in the rich soil of accomplishment to hold the pupil's attention to study. The research and industrial groups of the American Chemical Society are now working with this knowledge which can be so valuable to high school teachers. Can the society bring about a *rapprochement* of these groups so that not only they but the public also may profit?

A quantitative analysis of aims in teaching high school chemistry: JACOB CORNOG and J. C. COLBERT. Data collected from 187 high schools in all parts of this country indicate that (1) text-books used are about 80 per cent. descriptive, final examination questions are 60 per cent. descriptive, while stress indicated by teachers' opinions is about 50 per cent. descriptive matter; (2) in many instances considerable inconsistency of aim exists between what teachers say they stress in instruction and what they ask in final examinations; (3) harmony of objective between different schools is lacking; (4) equation writing and chemical arithmetic receive much unity of stress; (5) geographical location of schools reveals no general modification of foregoing observations.

Quantitative analysis of aims in teaching freshmen chemistry: JACOB CORNOG and J. C. COLBERT. Data, concerning aims in teaching freshmen chemistry, collected from 27 American colleges and universities indicate that (1) College texts are about 70 per cent. descriptive matter, final examination questions are about 40 per cent. descriptive, while stress indicated by teachers' opinions is about 30 per cent. descriptive; (2) in many individual instances considerable inconsistency exists between what teachers say they stress in instruction and what they ask in final examinations; (3) harmony of objective between different institutions, while not perfect, is very fair; (4) equation writing and chemical arithmetic receive much unity of stress; (5) among teachers a widespread feeling exists that college courses are too full and that results lack thoroughness; (6) recent advances are slow in finding place in curricula; (7) contrasted with high school chemistry, except in content of texts, college chemistry is preponderantly theoretical, while high school chemistry is correspondingly descriptive.

NEIL E. GORDON,
Secretary